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Westinghouse

ELECTRIC CORPORATION

AIR ARM DIVISION

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BOX 746, BALTIMORE 3, MD.

19 November 1957

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[redacted]

SUBJECT: Contract TA-3034
Westinghouse Reference AAD-30465

Forwarded herewith are five (5) copies of Revision of Design Specifications for the Terrain Avoidance Radar System dated 24 October 1957, which amends Design Specification dated 28 June 1957.

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Sales Engineer

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CONFIDENTIAL

October 24, 1957

REVISION OF DESIGN SPECIFICATIONS

for the

TERRAIN AVOIDANCE RADAR SYSTEM

It has been decided to reduce the antenna size and eliminate the antenna servo. This allows a faster scan and makes it necessary to mount the magnetron separate from the antenna.

Difficulty has been encountered in finding a location for an antenna as large as the proposed antenna. The frontal area exacts a heavy penalty on aircraft performance. Since these problems are likely to be equally severe in any other aircraft, it has been decided to reduce the antenna size. This means that the beamwidth will be greater. Originally a 24" by 18" antenna with a 1° vertical by 1.5° horizontal beamwidth was proposed. The antenna will be reduced to 12" x 15" with a 2° x 2° beamwidth. At 1.5 nautical miles (the limit of the red range) one beamwidth is 300' as compared with 150' in the vertical plane for the larger antenna. In the original proposal 150' resolution was chosen as adequate and no attempt was made to estimate to what fraction of a beamwidth an object could be resolved. This is a function of several variables but resolution at least some better than one beamwidth can be expected. A strong case cannot be made for beamwidth better than 2° in terms of ability to avoid obstacles. Even a one degree beamwidth theoretically appears to present a coarse picture if the image is considered to be made up of 1° elements of constant intensity. The actual image made up of shaded elements and viewed from a reasonable distance should be acceptable for a 2° beamwidth. The smaller antenna has a two way gain of 79 db as compared to 87 db for the larger antenna. This results in an estimated strong signal range of about 6 miles as compared to 9.5 miles with the larger antenna.

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The maximum permissable scan rates are fixed by considerations of hits per beamwidth and magnetron duty cycle for a given sector coverage. With the wider beamwidth antenna it becomes possible to increase either scan rates or sector coverage. The horizontal sector coverage cannot be increased as the present 30° is the maximum feasible using horn feed scanning. It appears more desirable to increase scan rate than the vertical sector coverage. The 2/3 cps vertical scan as proposed is so slow as to cause picture smearing during a turn due to aircraft travel during the time required to present one frame. Maintaining the same number of hits per beamwidth with the new antenna, it is possible to increase the horizontal scan rate to 22.5 cps and the vertical scan rate to approximately 2 cps. A modified triangular sweep will be used. The exact frequency will depend upon the reversal time required.

The antenna servo to correct for drift angle will be eliminated. Several considerations make this desirable. While it might be useful in level flight to equalize coverage to either side of the aircraft, this is not too important unless wind velocity is high. On the other hand, it appears that in banking and turning in mountainous country it may degrade system performance. The projected flight path can be visualized due to the apparent drift of objects to either side of this path in the presence of a drift angle. Only objects along the flight path will not drift horizontally. In maneuvering, the doppler radar cannot function to measure drift angle when the bank angle exceeds a few degrees. When this occurs it goes into a memory mode and uses the last known wind to compute drift angle. This system will be useful primarily in maneuvering through mountainous terrain to approach a target area. It appears that wind is extremely variable in mountainous country and in banking around a mountain the wind will very likely change. Under these conditions, the doppler data may cause the antenna servo to position the antenna so as to produce a greater misalignment than if no correction were made. For these reasons the servo was eliminated.

In addition the doppler radar in the aircraft under consideration has no wind computer so that it furnishes no information during banking. A lightweight wind computer for this radar has been quoted at $110,000 by the manufacturer. The additional motion if the antenna is servoed increases the radome diameter by about 2 inches.

The transmitter will not be mounted on the back of the antenna as previously proposed. The smaller antenna design makes it necessary to design such a compact unit that serviceability is poor. In addition, it is impossible to balance the antenna assembly with the transmitter mounted on the back. It is about 25 lbs. off balance with a center of mass about 4 inches from the center about which the scan motion is performed to minimize radome frontal area. At a scan rate of 2 cps it is undesirable to have the extra weight to move even if it is balanced.